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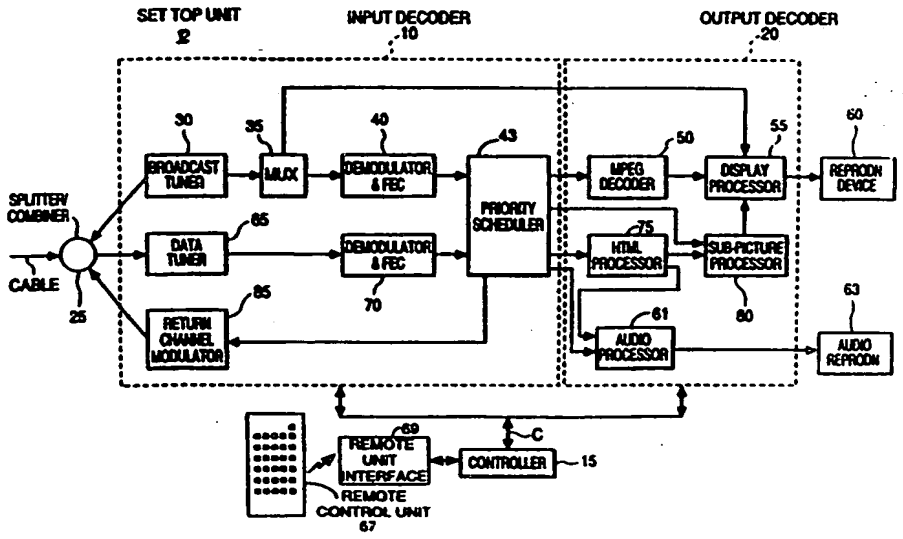

(57) Abstract

Apparatus (10, 20) decodes input video data which is encoded in different data formats and is received on a common physical communication link. The decoder includes a first processor (50) for decoding image representative data which is packetized in an Internet protocol compatible data format and is received on the common communication link. The decoder also includes a second processor (75) for concurrently decoding broadcast video data which is packetized in an MPEG compatible data format exclusive of the Internet protocol data format and is received on the common communication link. The first and second processors produce first and second decoded video outputs respectively. Also, the proportion of the image representative data conveyed on the common communication link relative to the broadcast video data may be dynamically varied. The decoder also includes a display processor (55, 80) for forming a display image from the first and second decoded video outputs.

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Multimedia Decoder and Bi-directional Broadcast Communication System

Field of the Invention

This invention concerns interactive bi-directional communication in a broadcast system, and more particularly to the decoding of multiple data services and their presentation to a User.

Background of the Invention

Home entertainment set-top box systems which combine Personal Computer and television functions (PC/TV functions) are increasingly becoming generic, User interactive, multiple source and multiple destination communication devices. Such systems are required to communicate in different data formats between multiple locations for a variety of applications in response to User requests. For example, a set-top box system may receive data from satellite or terrestrial sources comprising High Definition Television (HDTV) broadcasts, Multi-point Microwave Distribution System (MMDS) broadcasts and Digital Video Broadcasts (DVB). A set-top box system may also receive and transmit data via telephone (e.g. the Internet) and coaxial lines (e.g. cable TV) and from both remote and local sources such as Digital Video Disk (DVD), CDROM, VHS and Digital VHS (DVHS™) type players, PCs, and many other types of sources.

It is desirable for a set-top box system to be able to support bi-directional communication and in-home control functions and to be able to access and decode information from multiple broadcast sources. It is also desirable for a set-top box

system to be able to seamlessly combine the decoded information for presentation to a User. There are a number of problems in achieving such a system. Specifically, problems arise in efficiently acquiring information of different data formats from different sources and prioritizing the processing of the information. These problems are addressed by a system according to the present invention.

Summary of the Invention

A decoder system advantageously incorporates separate tuner, demodulator and processing paths for concurrent and scaleable (dynamically variable bit-rate) processing and decoding of broadcast image representative data encoded in different data formats and received on a common physical communication link. The decoder system also advantageously incorporates a separate return channel communication path permitting secure return communication with a broadcast source on the common communication link.

Brief Description of the Drawings

In the drawing:

Figure 1 shows a scaleable decoder system for efficiently communicating with a plurality of sources and for processing exemplary TCP/IP and MPEG format data, according to the invention.

Figures 2 and 3 present exemplary characteristics of the broadcast, data and return channels depicted in the system of Figure 1, according to the invention.

Figures 4 and 5 list the data traffic type and an exemplary bit rate allocation for services provided via the upstream channel and downstream channels of figure 1.

Figure 6 shows a priority schedule system for prioritizing processing of broadcast and data packets for bi-directional applications, according to the invention.

Figure 7 shows a flowchart of a method for prioritizing processing of broadcast and data packets suitable for use in the system of Figure 6, according to the invention.

Figure 8 shows a server distribution hub for distributing broadcast data from a plurality of service providers to the decoder of Figure 1 and for processing upstream data from the decoder of Figure 1, according to the invention.

Figure 9 lists and describes the exemplary interfaces 1-10 identified in the server system of Figure 8, according to the invention.

Detailed Description of the Drawings

Figure 1 shows a decoder system providing efficient communication with a plurality of sources, according to the invention. The decoder system advantageously incorporates separate tuner, demodulator and processing paths for concurrent processing and decoding of data encoded in different data formats. The decoder system also advantageously incorporates a separate return channel communication path permitting secure return communication with a broadcast source, for example. The exemplary embodiment of Figure 1 supports decoding of data in TCP/IP (Transmission Control Protocol/Internet Protocol) and MPEG (Motion Picture Experts Group) format (e.g. per MPEG2 ISO/IEC 13818-1 of 10th June 1994, and ISO/IEC 13818-2, of 20th January 1995). In addition, the set-top box system of Figure 1 is compatible with the Multimedia Cable Networks Systems (MCNS) preliminary requirements.

The architecture of Figure 1 enables scaleable (i.e. dynamically variable bit-rate) concurrent decoding of image

representative data from separate sources in different formats. As such, data of different data formats may be processed by the scaleable decoder system of Figure 1 without being encoded in accordance with an encompassing higher layer communication format. Thereby, the decoder system avoids the overhead and inefficiency involved in processing data hierarchically encoded using such an additional communication format.

The decoder system also incorporates a scheduler system for prioritizing the processing of both received data and data for return communication to a broadcast source, for example. The received and return data is allocated a desired hierarchical data output priority based on features including, a) a function associated with the data, b) a protocol characteristic of the data, or c) a physical communication channel by which the data is conveyed. Exemplary functions performed by the decoder include i) Email, ii) Internet web page browsing, iii) Internet telephony, iv) conventional telephony, v) fax, vi) videophone, vii) broadcast video, audio and radio processing and viii) home control functions. The desired hierarchical data output priority is derived from a priority profile or map. The priority profile comprises a database allocating a relative priority to data packets associated with an individual function, protocol characteristic, or communication channel. The information in the priority profile comprises pre-stored default information, user entered information, or information broadcast to the decoder from a service provider, for example. The profile may also comprise information derived from several of these sources.

Although the decoder system is described as processing data received via co-axial cable in MPEG and Internet protocol compatible format, this is exemplary only. The decoder system processes data supporting functions including Email, Internet web page browsing, Internet telephony, conventional telephony, fax, videophone, broadcast video, audio and radio and home control functions. Further, the principles of the invention may be applied to systems in which the types of transmission channels and communication protocols may vary, or to systems in

which the coding and modulation types may vary. Such systems may include, for example, satellite, terrestrial, Internet and intra-net broadcast and communication systems employing non-MPEG and non-Internet compatible protocols. Further, the invention principles apply to the processing of any form of data such as telephone messages, computer programs, Internet data or other communications, for example.

In overview, in set-top box system 12 of Figure 1, a first carrier modulated with broadcast video data and a second carrier modulated with Internet data, e.g. web page information, is received by splitter/combiner unit 25 and processed by input decoder 13. Unit 13 tunes to the respective first and second carriers and demodulates, forward error corrects and prioritizes the received data to provide demodulated digital data for further processing by output decoder 20. Unit 13 also derives an analog video signal from the received data and provides the signal to unit 20. Unit 20 processes the digital data including MPEG compatible video and audio data and Internet protocol data for display and audio reproduction by units 60 and 63 respectively. In another mode unit 20 also processes the analog video data from unit 13 for display by device 60.

A set-top box user selects a function to be performed, e.g. the viewing of a particular program or web page data, by on-screen menu selection and cursor command using remote control unit 67. Unit 15 controls the operation of the elements of input decoder 13 and output decoder 20 and responds to remote control unit 67 commands using a bi-directional data and control signal bus C. Controller 15 controls the functions of individual elements within units 13 and 20 by setting control register values within these elements with control bus C. In addition, unit 15, in conjunction with unit 13, initiates and prioritizes the generation and transmission of messages for return communication on the coaxial cable link to a service provider, for example.

Considering Figure 1 in detail, splitter/combiner 25 provides a frequency multiplexed signal incorporating first and second Quadrature Amplitude Modulated (QAM) carriers to tuners

30 and 65. The first and second carriers are independently QAM modulated using a selectable symbol constellation of either 256 or 64 points. Tuner 30 derives a first carrier modulated with MPEG compatible program representative audio, video and associated data from the frequency multiplexed signal. Tuner 65 derives a second carrier modulated with Internet protocol web page representative data from the frequency multiplexed signal. Tuners 30 and 65 include frequency demultiplexer, radio frequency (RF) tuner and intermediate frequency (IF) mixer and amplification stages for down-converting the signal from unit 25 to lower frequency bands to derive the first and second carriers respectively.

Tuner 30, in conjunction with controller 15, determines whether the first carrier contains digital MPEG compatible video data or comprises an analog video signal. A digital video data representative first carrier is provided by tuner 30 to demodulator 40 via multiplexer (mux) 35 and an analog video signal is provided via mux 35 to display processor 55 in output decoder 20. Tuner 65 provides the second carrier to demodulator 70. In this exemplary system, the input frequency multiplexed signal from unit 25 contains 33 Physical Transmission Channels (PTCs 0-32). Each Physical Transmission Channel (PTC) is allocated a 6 MHz bandwidth and contains, for example, up to 6 sub-channels each with unique carrier frequency.

It is assumed for exemplary purposes that a set-top box user selects a sub-channel (SC) for viewing using remote control unit 67. Controller 15 uses the selection information provided from remote control unit 67 via interface 69 to appropriately configure elements of input decoder 13 to receive the PTC and corresponding carrier frequency of the selected sub-channel SC. Following down conversion, the first carrier output signal from tuner 30 for the selected PTC has a bandwidth of 6 MHz and a center carrier frequency in the range of 54-806 MHz. In the following discussion, an RF channel or Physical Transmission Channel (PTC) refers to an allocated broadcaster

transmission channel band which encompasses one or more sub-channels.

Controller 15 configures the radio frequency (RF) tuner and intermediate frequency (IF) mixer and amplification stages of tuner 30 to receive the selected PTC first carrier frequency. The down-converted first carrier frequency output for the selected PTC provided by tuner 30, via mux 35, is demodulated by unit 40. The primary functions of demodulator 40 are recovery and tracking of the carrier frequency, recovery of the transmitted data clock frequency, and recovery and forward error correction of the MPEG compatible video data itself. Unit 40 also recovers sampling and synchronization clocks that correspond to transmitter clocks and are used for timing the operation of tuner 30, demodulator 40 and scheduler 43.

Unit 40 demodulates the QAM modulated first carrier signal to provide demodulated digital output data. Also, in unit 40, the demodulated digital output data is mapped into byte length segments which are deinterleaved and Reed-Solomon error corrected according to known principles. In addition, unit 40 provides a Forward Error Correction (FEC) validity or lock indication to controller 15. Reed-Solomon error correction is a known type of Forward Error Correction. The FEC lock indication signals that the Reed-Solomon error correction is synchronized to the data being corrected and is providing a valid output. It is to be noted that the tuning, demodulator and decoder functions implemented by units 30 and 40 (and also units 65 and 70) are individually known and generally described, for example, in the reference text *Digital Communication*, Lee and Messerschmidt (Kluwer Academic Press, Boston, MA, USA, 1988). The recovered output from unit 40 is in the form of an MPEG compatible transport datastream containing program representative multiplexed audio, video and data components. This transport stream is provided to scheduler 43.

The second carrier, modulated with Internet protocol web page representative data, is derived by tuner 65 and demodulated and error corrected by unit 70. Tuner 65 and

demodulator 70 duplicate the tuner and demodulator functions of units 30 and 40 respectively and advantageously provides an independent processing path permitting concurrent processing of Internet protocol data and MPEG compatible data, for example. Tuner 65 and demodulator 70 operate in the manner previously described in connection with corresponding units 30 and 40. Tuner 65 and demodulator 70 provide data to scheduler 43 in Internet protocol format representing a user selected web page.

Scheduler 43 in conjunction with controller 15 prioritizes both the Internet protocol data from demodulator 70 and the MPEG compatible transport stream data from demodulator 40, for processing by elements of output decoder 20. Scheduler 43 and controller 15 also prioritize the data for return communication via the coaxial cable link to a broadcast source, for example. Scheduler 43, under control of unit 15, identifies individual Internet protocol packets from unit 70 representing a specific function e.g. web page information requested via a web browser. In addition, scheduler 43, under control of unit 15, identifies individual MPEG compatible packets representing a specific program e.g. "Seinfeld™" on a selected channel NBC™ and associated data. The associated data comprises packet identification and assembly information supporting the MPEG decoding and recovery of a program and also includes ancillary sub-picture information for display such as program guide data.

Scheduler 43 incorporates a demultiplexer for matching the PIDs of incoming MPEG packets in the datastream from unit 40 with PID values pre-loaded in control registers within unit 43 by controller 15. Similarly, scheduler 43 matches data identifiers such as data source and data destination, data type, IP address, and Universal Resource Locator (URL) codes in the Internet protocol datastream from unit 70 with values pre-loaded in control registers within unit 43 by controller 15. This matching process serves to identify the function and program representative Internet and MPEG data packets for prioritizing and further processing. The resultant identified Internet and

MPEG packets are stored in memory and sequentially accessed in accordance with a predetermined priority profile (map) associating data having a specific characteristic and function with a desired priority. Thereby, unit 43 provides buffered prioritized Internet protocol data including web page HTML™ (Hyper Text Mark-up Language) and associated Java™ data (and other data e.g. JPEG, GIF, TIF type data) to HTML™ processor 75. Unit 43 also provides the prioritized MPEG video, audio and sub-picture packets to MPEG video decoder 50, audio processor 61 and sub-picture processor 80 respectively. The method of operation of scheduler 43 and its implementation is described later in more detail in connection with Figures 6 and 7.

MPEG decoder 50 decodes and decompresses prioritized MPEG compatible packetized video data from unit 43 and provides prioritized decompressed program representative pixel data for storage in the pixel representative memory in display processor and NTSC encoder 55. Audio processor 61 decodes prioritized packetized audio data from unit 43 and provides prioritized decoded and amplified audio data synchronized with the associated decompressed video data to device 63 for audio reproduction. Processor 75 decodes the HTML™ and Java™ encoded web information from unit 43 and provides web page image representative pixel data for storage in memory within sub-picture processor 80. Processor 75 also decodes data encoded in other formats e.g. JPEG, TIF, GIF formats and in other mark-up languages e.g. SGML (Standard Generalized Mark-up Language) and provides the decoded data to sub-picture processor 80 for further processing. Processor 80, under direction of controller 15, formats the stored web page image pixel data for storage as an overlay in the pixel representative memory contained in display processor 55 for reproduction by unit 60 as a merged display. In addition, controller 15 incorporates a web page browser supporting execution of a full complement of web page browser functions. Thereby unit 15, together with processor 75 and processor 80, provide a display via unit 60 of either a custom

web page browser or a standard browser such as Netscape Navigator™ through which full Internet access is available.

Sub-picture processor 80 incorporates an On-Screen Display (OSD) text and graphics generator used in decoding and processing sub-picture data from unit 43. Processor 80 also uses its internal OSD generator in creating pixel mapped data representing program guide, subtitling, control and information menu displays including selectable menu options, and other ancillary items. The text and graphics produced by processor 80 are generated in the form of overlay pixel map data under direction of controller 15. This overlay pixel map data is combined and synchronized with the decompressed pixel data from MPEG decoder 50 and decoded Internet protocol web page data from processor 75 in the pixel representative memory contained in display processor 55. Combined pixel map data representing a video program on sub-channel SC from unit 50 together with web page display data and associated sub-picture text message data from unit 80 is encoded as an NTSC signal by processor 55 and output for reproduction by unit 60 as a merged display. Unit 55, in another mode, also encodes the analog video signal provided via mux 35 from tuner 30 as an NTSC signal for output and reproduction by unit 60.

Set-top box system 12 supports a full complement of multimedia functions in addition to the described exemplary web browsing and MPEG video processing functions. These multimedia functions include, for example, Email, Internet telephony, conventional telephony, fax, videophone, radio, broadcast audio, storage and home control functions. The decoding and prioritization principles detailed herein are also applied in the processing of data for such multimedia functions. For example, in the processing of Internet telephony data, processor 75 decompresses and decodes compressed audio data encoded in Internet protocol format and assigned a high level e.g. real time processing priority by unit 43. The decompressed audio data is provided by processor 75 to unit 63 for audio reproduction. Further, processor 75 incorporates functions for the processing of

multimedia data in different data formats and protocols for presentation to a user following processing by units 80, 55, 60, 61 and 63 in a manner similar to that previously described.

Controller 15, in conjunction with modulator 85 and scheduler 43, initiates and implements return channel communication with an Internet or broadcast service provider on the coaxial cable input link via splitter/combiner 25. A message request for Internet web page information (or a request associated with another function), for example, may be initiated by user selection of a displayed menu option on unit 60. Controller 15, in conjunction with unit 85 and scheduler 43 generates, prioritizes, and encodes the web page request message for transmission to a service provider on the coaxial cable link via unit 25. Controller 15 also determines whether the requested Internet access is authorized from conditional access or smart card user entitlement information e.g. from a smart card unit (not shown to simplify the drawing). If the requested Internet access is authorized, controller 15 initiates communication with a service provider on the return channel. Controller 15, in conjunction with units 43 and 85, establishes communication with the service provider using pre-stored request access data (such as telephone number, IP address, URL code and conditional access data) and generates web page request message data. The generated request message data is in Internet protocol format and incorporates the appropriate source, destination and IP address codes.

Scheduler 43 stores and buffers the web page request message data packets in memory and sequentially accesses the packets in accordance with a predetermined priority profile (map) associating return data having a specific characteristic and function with a desired priority. Thereby, unit 43 provides buffered prioritized web page request message data to modulator 85. Modulator 85 forward error corrects, interleaves and encodes the request message data using QPSK (Quaternary Phase Shift Keying) modulation. Unit 85 also optionally encrypts the request message data (under direction of controller 15) in a secure data format and transmits the encoded data with the desired priority

to a service provider via the cable link and unit 25. Unit 85 may alternatively code, scramble or interleave the request message (or other return data) or employ other protection mechanisms to enhance data security. Such data security is of particular importance in electronic transaction type messages e.g. involving credit card data. In addition, the return channel may also be used for functions such as a) telemetry including meter reading, b) video and alarm monitoring, c) home environment monitoring, d) home appliance monitoring, e) merchandise ordering and f) program conditional access and entitlement management. The method of prioritizing received and return data employed by scheduler 43 is described later in more detail in connection with Figures 6 and 7.

As previously described, the architecture of the set-top box system of Figure 1 provides independent concurrent processing of broadcast data in different formats and from different sources (e.g. MPEG program data from a broadcast source and Internet protocol web page data from an Internet service provider). This architecture is fully scaleable and enables the decoding of dynamically partitionable data and bandwidth between the two downstream (e.g. MPEG and Internet) processing paths. As such, the architecture supports concurrent decoding of an MPEG broadcast of an HBO movie and accompanying Internet web page data, for example. In this example, the accompanying web page data is intermittent and the bandwidth occupied by the web page data may be dynamically re-allocated to the MPEG data or other supplementary data services e.g program guide, Email etc. The architecture also permits the dynamic partitioning of bandwidth between the return channel path and the two downstream processing paths.

Figure 2 shows exemplary characteristics of the downstream Internet protocol data and MPEG broadcast video channels. Although Figure 2 shows identical characteristics for both downstream channels, this is exemplary only and the characteristics may be different for each channel. Figure 3 shows exemplary characteristics of the upstream return communication

channel. Figure 4 lists the data traffic type and an exemplary bit rate allocation for services provided via a downstream channel of figure 1. Figure 5 lists the data traffic type and an exemplary bit rate allocation for services provided via the upstream channel of figure 1. The processing architecture of the set-top box system 12 of Figure 1 is fully scaleable and is capable of adaptively processing data dynamically allocated between the two downstream channels. Set-top box system 12 is also capable of adaptively processing data occupying a bandwidth that is dynamically allocable between the downstream channels and the return channel.

Figure 6 shows a priority schedule system for prioritizing processing of MPEG broadcast and Internet protocol data packets received from units 40 and 70 (Figure 1) respectively. The system of Figure 6 is also used for prioritizing processing of data for return communication to a service provider via unit 85 (Figure 1). In the system of Figure 6, input data e.g. MPEG, Internet protocol TCP/IP or return data is placed in an input storage stack 600. Network interface 610 identifies the type of received data in stack 600 (e.g. MPEG, Internet protocol or return data) and formats it for identification of characteristics (attributes) by intelligent scheduler 620. Scheduler 620 responds to control and synchronization messages 615 from controller 15 (Figure 1) in performing intelligent scheduling functions.

Scheduler 620 (Figure 6) examines the formatted data from interface 610 for function, protocol and communication channel attributes contained in priority profile 640 stored in internal DRAM storage. Scheduler 620 also compares attributes in the received data with attributes in the priority profile and collates the received data packets by desired output priority based on this comparison. Scheduler 620 allocates storage in sequential output FIFO (First-In First-Out) unit 650 based on the desired output priority (e.g. critical, high, medium or low priority - 640) and provides the collated prioritized data to allocated storage locations in FIFO 650 via a high speed DMA (Direct Memory Access) interface 630. Output processor 660 sequentially accesses

the prioritized data from FIFO 650 and formats it for further processing by units 40, 70 and 85 (Figure 1).

Figure 7 shows a flowchart detailing a method for prioritizing processing of input MPEG broadcast data, Internet protocol data and return data suitable for use in the system of Figure 6. In step 705 of Figure 7, following the start at step 700, scheduler 620 (Figure 6) receives input data and in step 710 retrieves priority profile information from memory. The priority profile hierarchically associates a particular desired output priority to input data exhibiting a particular attribute or combination of attributes. The priority profile may be transmitted from a service provider, entered by a user or may comprise pre-stored default information or may be derived from a combination of these sources. A service provider is able to provide different grades of service each offering a user different data access times at corresponding different billing rates by downloading a priority profile to a user's set-top box system. The downloaded priority profile enables the service provider to control user access to received information. For example, by downloading (or pre-installing) a priority profile, an Internet service provider may provide Internet access at a minimum data rate of 1 kbit per second at $10 per month and 5 kbits per second at $20 per month. Alternatively, a user may enter priority profile information to configure his system to process and communicate data or messages in a desired order or with a desired precedence.

The priority profile information may be security encoded e.g. by encryption, scrambling or coding for data protection purposes in order to prevent unauthorized use of the high speed and premium data access levels of service. In this case, the priority profile information is decoded (e.g. decrypted or descrambled) by controller 15 (Figure 1) in conjunction with scheduler 620 (Figure 6), prior to its use. Such decryption or descrambling may be authorized and implemented in a conditional access and entitlement management system in the set top box system 12 of Figure 1 (not shown to preserve drawing clarity). It is to be noted that the priority profile may be transmitted to any

and all nodes in a network system such as the Internet or an intra-net, LAN or WAN etc. for assuring quality of service (QOS). The nodes may include network devices such as servers (distribution hubs), gateways, terminals, routers and switches. The priority profile may also be distributed and used in conjunction with communication protocols incorporating data priority indicators for reserving network resources to ensure quality of service throughout a network communication path or merely for sections of a path. Such communication protocols include, for example, Resource ReServation Protocol (RSVP) Internet draft June 14 1997; Real-time Transport Protocol (RTP) Request for Comment document RFC 1889, February 1, 1996, both documents being available on the Internet. The priority profile information may also be used in systems operating in accordance with standards defining system elements for multimedia networking and communication such as H.323 of November 1996 and H.324 developed by the International Telecommunication Union (ITU).

In step 715 of Figure 7, scheduler 620 identifies attributes in data received in step 705. The attributes identified include (i) protocol characteristics, (ii) function type characteristics and (iii) communication channel characteristics.

The protocol characteristics include, for example, (a) a data source identifier, (b) a data destination identifier, (c) a data type identifier, (d) a data priority indicator, (e) a data error indicator, (f) an entitlement indicator, (g) an Internet protocol indicator, (h) an MPEG compatible indicator, and (i) a packet identifier.

The function type characteristics identify, for example, functions including a) Email, b) Internet web page browsing, c) Internet telephony, d) conventional telephony, e) fax, f) broadcast video processing, g) videophone processing, h) broadcast radio processing, i) broadcast audio processing and j) home control functions such as alarm, telemetry, appliance and environment control and monitoring.

The communication channel characteristics identify the type of physical communication link e.g. telephone line, terrestrial,

cable or satellite link, fiber optic link, Wide Area Network (WAN), Local Area Network (LAN), Internet, or intra-net. The communication channel characteristics also identify different channels of the same type of communication link e.g. different telephone lines.

In step 720 of Figure 7, scheduler 620 compares attributes identified in step 715 with attributes in the priority profile and in step 725 collates the packetized input data by desired output priority based on this comparison. The use of a priority profile in this manner provides a flexible means of structuring the priority of a wide variety of data derived from a plurality of different sources. Data may be advantageously prioritized by any combination of communication link, protocol or function characteristics. Thereby data of a particular function, or data communicated on a particular link, may be prioritized by source or destination or type. Email messages, for example, may be prioritized according to source identifier i.e. Email from certain sources may be given higher priority. Similarly, return messages to specific destinations (identified by destination identifier) may be allocated and coded with a higher priority. Further, scheduler 620 interprets dedicated priority indicators e.g. an Internet protocol data type (precedence) indicator in the input data and allocates this data the appropriate priority. Similarly, hierarchical processing priority may also be allocated using the priority profile based on entitlement indicators, Internet protocol indicator, MPEG compatible indicator e.g. packet identifiers.

In step 730, scheduler 620 allocates storage in a sequential output FIFO (First-In First-Out unit 650 of Figure 6) based on the desired output priority and provides the collated prioritized data to the allocated storage locations in FIFO 650 via a high speed DMA (Direct Memory Access) interface 630. The collated prioritized packet data is output from FIFO 650 with the desired output priority in step 733 (Figure 7). In step 735, the collated prioritized output data is processed for reproduction and presentation to a user or for return transmission to a service provider. Such processing may involve encoding and encrypting

the data for secure return communication, for example, and synchronizing the data with other set-top box processes. The process ends at step 740.

Figure 8 shows a server distribution hub 102 for distributing broadcast data and providing multimedia services from one or more service providers 109 to the set-top box system 12 (Figure 1 and 8) and for processing upstream data from unit 12, according to the invention. QAM modulated broadcast data such as MPEG compatible video data or analog representative video data from one or more service providers 109 (Figure 8) is provided via optical fiber link 145 and channel 135 to mux 125. Unit 125 provides a multiplexed output from sources including the received broadcast data from channel 135, local hub generated data 137, and from QAM modulated data from cable modem termination 150 (via up converter 134). The multiplexed output from mux 125 is output to optical fiber communication interface 120. Unit 120 communicates with set-top box system 12 of Figure 1 by transmitting downstream QAM data and receiving upstream QPSK (or QAM) data on high frequency channel 110 via optical fiber link 115, coax 105 and electrical to optical converter 107.

Upstream data from set box 12 is received by unit 120 via channel 110 and routed via splitter 155 and down converter 160 to cable modem termination system 150. System 150 demodulates the QPSK modulated upstream data from converter 160 and provides the demodulated upstream data to service provider 109 via network interface 154, optional hub switch 140 and optical fiber link 145. Alternatively, optional hub switch 140 may provide the demodulated upstream data to an optional WAN device 130. Unit 154 of system 150 also receives downstream data from service provider 109 or WAN device 130 via switch 140. Unit 154 formats and processes the downstream data from switch 140 and provides it to unit 152 for QAM modulation and subsequent up conversion by converter 134. The up-converted data from converter 134 is transmitted to set-top box system 12 via mux 125 as previously described.

Figure 9 lists and describes the exemplary interfaces 1-10 identified in the server system of Figure 8, according to the invention.

The architectures of Figures 1, 6 and 8 are not exclusive. Other architectures may be derived in accordance with the principles of the invention to accomplish the same objectives. Further, the functions of the elements of system 12 of Figure 1 and the process steps of Figure 7 may be implemented in whole or in part within the programmed instructions of a microprocessor.

CLAIMS

1. Video decoder apparatus (10,20) for decoding input video data encoded according to a plurality of different data formats and received on a common physical communication link, comprising:

a first processor (50) for decoding image representative data packetized in an Internet protocol compatible data format and received on said common communication link, to provide a first decoded video output;

a second processor (75) for concurrently decoding broadcast video data packetized in an MPEG compatible data format exclusive of said Internet protocol data format and received on said common communication link, to provide a second decoded video output, wherein the proportion of said image representative data conveyed on said common communication link relative to said broadcast video data may be dynamically varied; and

a display processor (55,80) for forming a display image from said first and second decoded video outputs.

2. Apparatus according to claim 1, including

a first demodulator (40) for demodulating data modulated in a first modulation format to provide said image representative data; and

a second demodulator (70) for demodulating data modulated in a second modulation format to provide said image representative data.

3. Apparatus according to claim 2, wherein

said first and second modulation formats are the same.

4. Apparatus according to claim 1, including

an encoder (43,15) for encoding data for return communication to a broadcast source; and

a modulator (85) for modulating encoded data in a return modulation format for return communication to a broadcast source via said common communication link.

5. Apparatus according to claim 4, wherein

said encoder is capable of sending messages via said return channel supporting one or more functions selected from a) telemetry including utility meter reading, b) video monitoring, c) an alarm function, d) home environment monitoring, e) home appliance monitoring f) merchandise ordering an g) program conditional access and entitlement management.

6. Apparatus according to claim 4, wherein

said return modulation format is different to a receiving modulation format.

7. Apparatus according to claim 1, wherein

said first processor is capable of processing messages via said common communication channel supporting one or more remote functions selected from a) video recorder programming, b) electronic transactions, c) videophone, d) Internet telephony, e) local community programming, f) merchandise ordering, g) targeted advertising, h) stock trading and i) home control.

8. Apparatus according to claim 1, including

a means for identifying data (15,35) received on said common communication link as analog broadcast format data and for processing said analog broadcast format data to provide data for display.

9. Apparatus according to claim 1, including

means for identifying synchronization indicators (15) in input data received on said common communication link for synchronizing said first decoded video output with said second decoded video output.

10. Video decoder apparatus for decoding input video data encoded according to a plurality of data formats and received on a common physical communication link, comprising:

a first processor (50) for decoding image representative data packetized according to an Internet protocol data format and received on said common communication link, to provide a first decoded video output;

a second processor (75) for decoding broadcast video data packetized according to an MPEG compatible data format exclusive of said Internet protocol data format and received on said common communication link, to provide a second decoded video output;

a third processor (15,43,85) for modulating encoded data in a return modulation format for return communication to a broadcast source via said common communication link; and

a display processor (55,80) for forming a display image from said first and second decoded video outputs.

11. Apparatus according to claim 10, wherein

said third processor collates information supporting one or more functions selected from a) telemetry including meter reading, b) video monitoring, c) an alarm function, d) home environment monitoring, e) home appliance monitoring, f) merchandise ordering, g) electronic transactions, h) program conditional access and entitlement management.

12. Apparatus according to claim 10, wherein said third processor encodes data in a secure data format.

13. Apparatus according to claim 12, wherein said secure data format is one or more of a) an encrypted format, b) a coded format, c) a scrambled format and d) an interleaved format.

14. Apparatus according to claim 10, wherein said return communication is secure by means of being point-to-point communication.

15. Apparatus according to claim 10, wherein said Internet protocol data format includes data encoded in at least one of a) HTML™ format, b) Java™ format, and c) ActiveX™ format.

16. Apparatus according to claim 10, wherein said first processor is capable of processing messages via said common communication channel supporting one or more remote functions selected from a) video recorder programming, b) electronic transactions, c) videophone, d) Internet telephony, e) local community programming, f) merchandise ordering, g) targeted advertising, h) stock trading and i) home control.

17. Video decoder apparatus for decoding input video data encoded according to a plurality of data formats and received on a common physical communication link, comprising:

a first processor (50) for decoding image representative data packetized according to an Internet protocol data format and received on said common communication link, to provide a first decoded video output;

a second processor (75) for decoding broadcast video data packetized according to an MPEG compatible data format exclusive of said Internet protocol data format and received on said common communication link, to provide a second decoded video output;

a third processor (15,43,85) for encoding data for return communication to a broadcast source via said common communication link;

means for synchronizing (15,55,80) said return communication with receiving data on said common communication link;

and

a display processor (55,80) for forming a display image from said first and second decoded video outputs.

18. Apparatus according to claim 17, including

means for identifying synchronization indicators (15) in input data received on said common communication link for synchronizing said first decoded video output with said second decoded video output.

19. A method for decoding input video data encoded according to a plurality of data formats and received on a common physical communication link, comprising the steps of:

decoding image representative data packetized according to an Internet protocol data format and received on said common communication link, to provide a first decoded video output;

decoding broadcast video data packetized according to an MPEG compatible data format exclusive of said Internet protocol data format and received on said common communication link, to provide a second decoded video output, wherein the proportion of said image representative data conveyed on said common communication link relative to said broadcast video data may be dynamically varied; and

forming a display image from said first and second decoded video outputs.

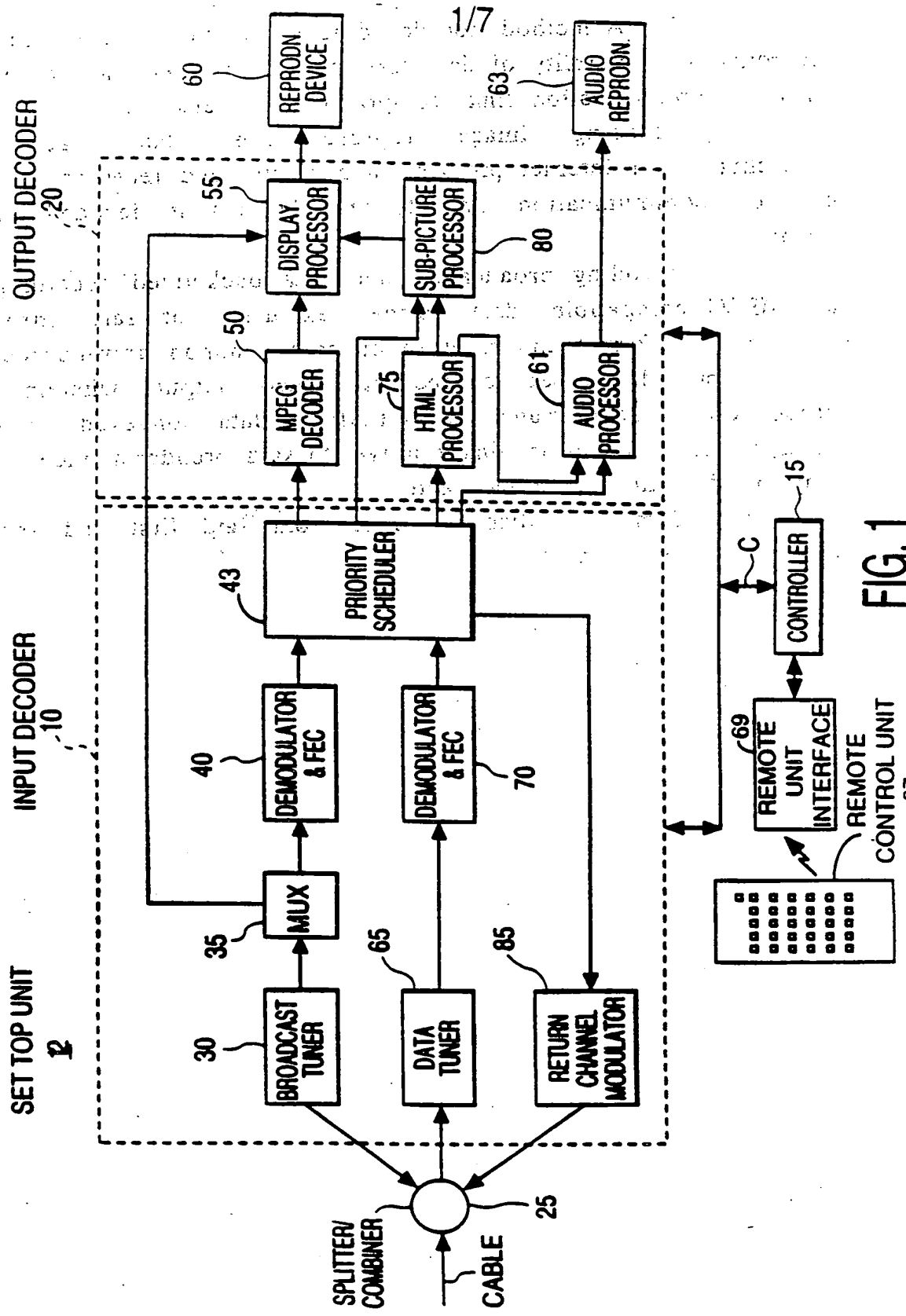

SET TOP UNIT
12
INPUT DECODER
10
OUTPUT DECODER
20
BROADCAST TUNER
30
MUX
35
DEMODULATOR & FEC
40
MPEG DECODER
50
DISPLAY PROCESSOR
55
REPRODN DEVICE
60
AUDIO PROCESSOR
61
AUDIO REPRODN
63
DATA TUNER
65
HTML PROCESSOR
75
SUB-PICTURE PROCESSOR
80
RETURN CHANNEL MODULATOR
85
DEMODULATOR & FEC
70
PRIORITY SCHEDULER
43
SPLITTER/ COMBINER
CABLE
25
C
CONTROLLER
15
REMOTE UNIT INTERFACE
69
REMOTE CONTROL UNIT
67

FIG. 1

BROADCAST & DATA CHANNEL	
CHANNEL BANDWIDTH	6 MHz
MODULATION FORMAT	64/256 QAM
SYMBOL RATE	5.057MS/sec, 5.361MS/sec
RAW TRANSPORT RATE	30.34Mbps (64QAM) 422.88Mbps (256QAM)
FEC	CONCATENATED REED-SOLOMON WITH VARIABLE DEPTH CONVOLUTIONAL INTERLEAVER
EFFECTIVE DATA RATE	27.01 Mbps (64 QAM) 38.15 Mbps (256 QAM)

FIG. 2

RETURN CHANNEL	
CHANNEL BANDWIDTH	0.2, 0.4, 0.8, 1.6, 3.2 MHz
MODULATION FORMAT	QPSK/16 QAM
SYMBOL RATE	0.16, 0.32, 0.64, 1.28, 2.56 MS/S
RAW TRANSPORT RATE	0.16 - 10.24 MB/s
FEC	SELECTABLE, E.G. REED SOLOMON, OR NONE
EFFECTIVE DATA RATE	0.1 - 10.24 MB/s

FIG. 3

DOWNSTREAM CHANNEL TRAFFIC TYPE	AVERAGE RATE
CONDITIONAL ACCESS FOR ANALOG SERVICES	20 Kbps
ENTITLEMENT MANAGEMENT MESSAGES (EMMS)	50 Kbps
BROADCAST DATA	20 Kbps
NETWORK MANAGEMENT	20 Kbps
MPEG OVERHEAD	800 Kbps
MCNS SIGNALING	5.2 Mbps
APPLICATION DOWNLOAD	10 Kbps PER ACTIVE SUBSCRIBER
EXTERNAL DEVICE DATA SERVICES	200 Kbps PER ACTIVE SUBSCRIBER
VBR DOWNLOAD	10 Kbps PER ACTIVE SUBSCRIBER
EPG DATA	UP TO 300 Kbps
EFFECTIVE BANDWIDTH AVAILABLE	21 Mbps (APPROX.)

FIG. 4

UPSTREAM CHANNEL TRAFFIC TYPE	AVERAGE RATE
NETWORK MANAGEMENT	20 Kbps
EXTERNAL DEVICE DATA SERVICES	20 Kbps PER ACTIVE SUBSCRIBER
MCNS SIGNING	500 Kbps
EFFECTIVE BANDWIDTH AVAILABLE	4.6 Mbps (APPROX.)

FIG. 5

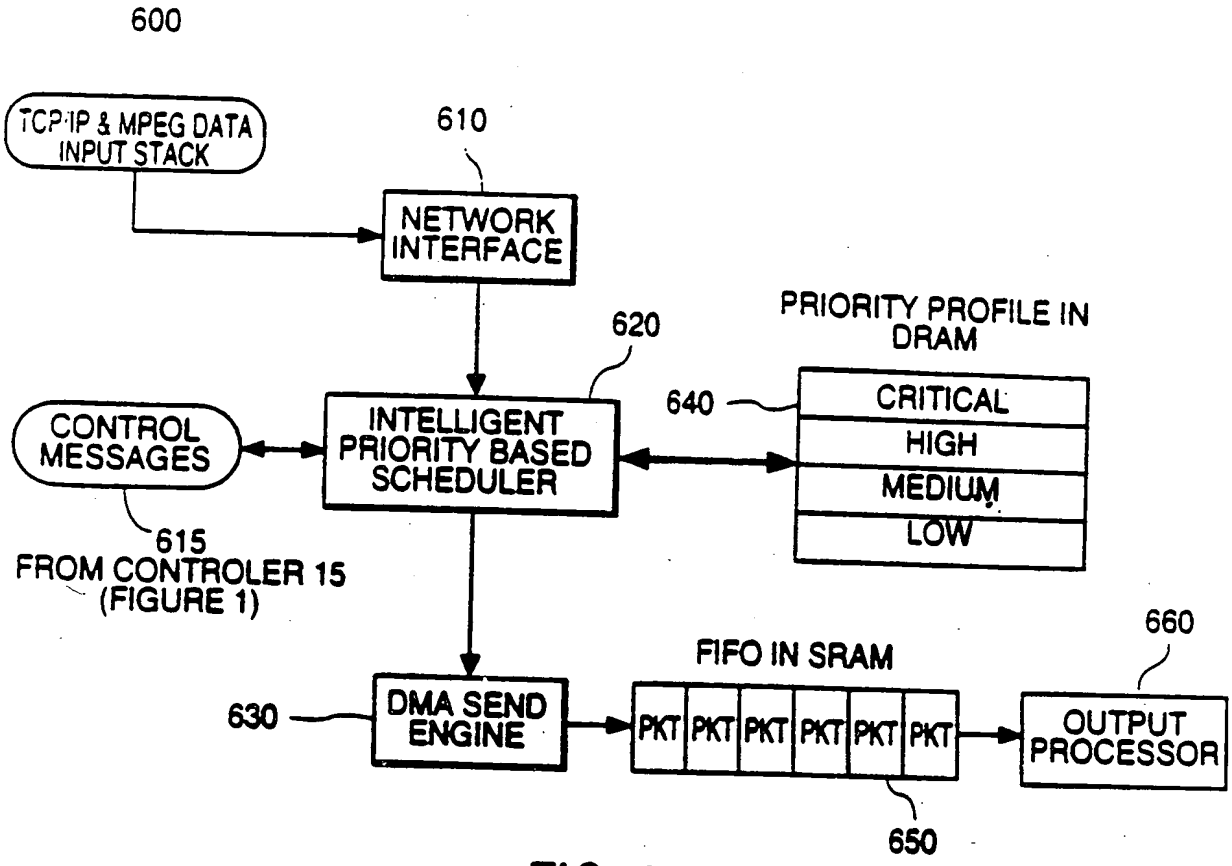
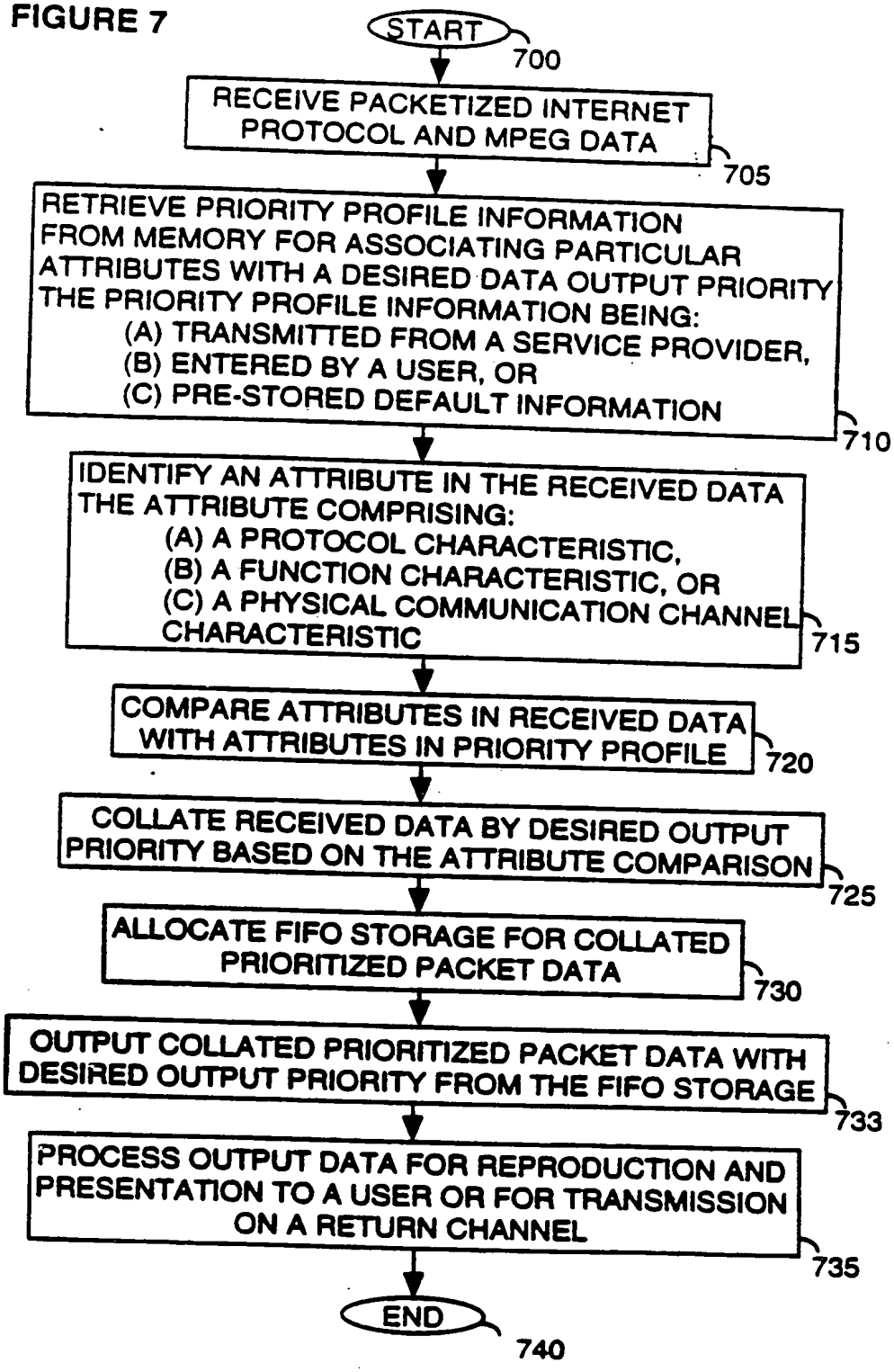

600
TCP/IP & MPEG DATA INPUT STACK
610
NETWORK INTERFACE
620
PRIORITY PROFILE IN DRAM
640
CRITICAL
HIGH
MEDIUM
LOW
CONTROL MESSAGES
INTELLIGENT PRIORITY BASED SCHEDULER
615
FROM CONTROLER 15 (FIGURE 1)
660
FIFO IN SRAM
630
DMA SEND ENGINE
PKT
PKT
PKT
PKT
PKT
PKT
OUTPUT PROCESSOR
650

FIG. 6

FIGURE 7


START
700
RECEIVE PACKETIZED INTERNET PROTOCOL AND MPEG DATA
705
RETRIEVE PRIORITY PROFILE INFORMATION FROM MEMORY FOR ASSOCIATING PARTICULAR ATTRIBUTES WITH A DESIRED DATA OUTPUT PRIORITY THE PRIORITY PROFILE INFORMATION BEING:
(A) TRANSMITTED FROM A SERVICE PROVIDER,
(B) ENTERED BY A USER, OR
(C) PRE-STORED DEFAULT INFORMATION
710
IDENTIFY AN ATTRIBUTE IN THE RECEIVED DATA THE ATTRIBUTE COMPRISING:
(A) A PROTOCOL CHARACTERISTIC,
(B) A FUNCTION CHARACTERISTIC, OR
(C) A PHYSICAL COMMUNICATION CHANNEL CHARACTERISTIC
715
COMPARE ATTRIBUTES IN RECEIVED DATA WITH ATTRIBUTES IN PRIORITY PROFILE
720
COLLATE RECEIVED DATA BY DESIRED OUTPUT PRIORITY BASED ON THE ATTRIBUTE COMPARISON
725
ALLOCATE FIFO STORAGE FOR COLLATED PRIORITIZED PACKET DATA
730
OUTPUT COLLATED PRIORITIZED PACKET DATA WITH DESIRED OUTPUT PRIORITY FROM THE FIFO STORAGE
733
PROCESS OUTPUT DATA FOR REPRODUCTION AND PRESENTATION TO A USER OR FOR TRANSMISSION ON A RETURN CHANNEL
735
END
740

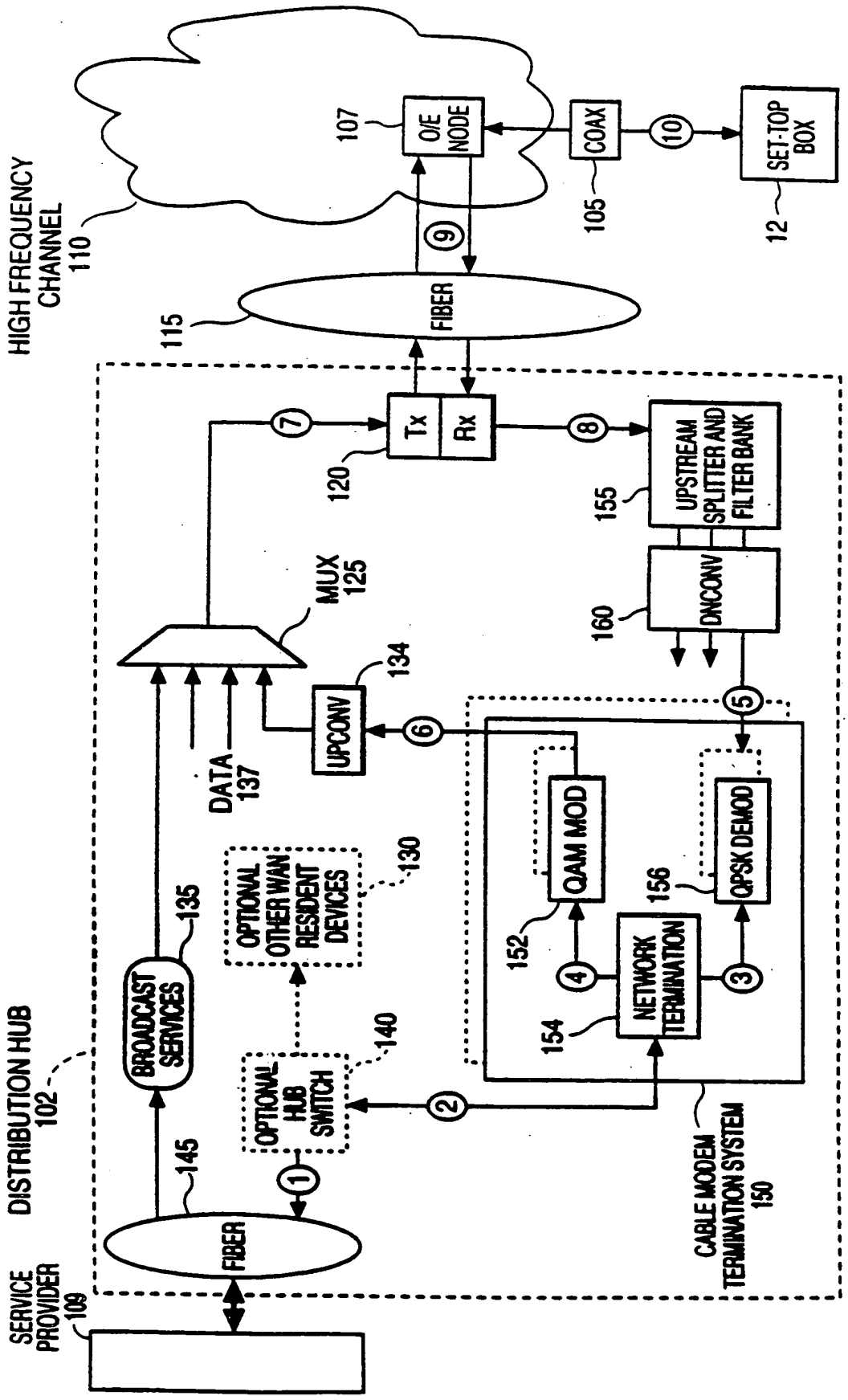

HIGH FREQUENCY CHANNEL 110
107
O/E NODE
COAX
105
10
SET-TOP BOX
12
9
FIBER
115
7
Tx
Rx
8
120
UPSTREAM SPLITTER AND FILTER BANK
155
MUX 125
DNCONV
160
134
UPCONV
6
5
DATA 137
OPTIONAL OTHER WAN RESIDENT DEVICES
130
135
BROADCAST SERVICES
QAM MOD
152
QPSK DEMOD
156
4
NETWORK TERMINATION
3
154
140
OPTIONAL HUB SWITCH
2
DISTRIBUTION HUB 102
145
1
FIBER
CABLE MODEM TERMINATION SYSTEM 150
SERVICE PROVIDER 109

FIG. 8

INTERFACE #	PHYSICAL FORMAT	DESCRIPTION
1	CABLE MODEM TERMINATION SYSTEM-NETWORK SIDE INTERFACE AND CABLE MODEM TERMINATION SYSTEM SECURITY MANAGEMENT INTERFACE FOR EXAMPLE, SONET ATM OVER OC-3, FAST ETHERNET OR ANOTHER INTERFACE	THIS IP BASED PHYSICAL INTERFACE SERVES SEVERAL LOGICAL FUNCTIONS: • ACCESS TO THE SECURITY AND ACCESS CONTROLLER SERVER. CABLE MODEM TERMINATION SYSTEM SECURITY MANAGEMENT INTERFACE. THIS COMMUNICATION LINK IS IMPLEMENTED USING A SECURE NETWORK ACCESS PROTOCOL SUCH AS REMOTE AUTHENTICATION DIAL-IN-USER SERVICE (RADIUS). THE SECURITY SERVER IS IMPLEMENTED ON AN OPEN COMPUTING PLATFORM, AND CAN RESIDE IN THE CENTRAL HEAD END AS A PART OF A PROXY SERVER CLUSTER. • DATA TRAFFIC. THIS INCLUDES ALL SERVICES PROVIDED OVER IP (DATA, VIDEO-ASSOCIATED DATA, INTERACTIVE PROGRAM GUIDES, AND OTHERS) TO THE STU AS A PART OF THE INTERACTIVE CHANNEL. • RETURN TRAFFIC GENERATED BY THE STU.
2	SAME AS 1 ABOVE, PROVIDED BY A LOCAL ATM SWITCH IN CASE MULTIPLE DEVICE ACCESS TO WAN AT THE LOCAL HUB IS DESIRED.	AS ABOVE
3	THE REVERSE DATA CHANNEL IS QPSK OR 16-QAM MODULATED OVER AN ELECTRICAL LINK.	2-10 Mbps RETURN DATA RATE DEPENDING ON THE CHARACTERISTICS OF THE CABLE SYSTEM AND THE MODULATION TECHNIQUE.
4	THE FORWARD DATA CHANNEL IS 64-QAM-MODULATED OR 256 QAM MODULATED OVER AN ELECTRICAL LINK.	27 Mbps FORWARD DATA RATE FOR 64-QAM MODULATED SYSTEM.
5	CABLE MODEM TERMINATION SYSTEM UPSTREAM RF SIDE INTERFACE (QPSK/16 QAM MODULATED).	MCNS VARIABLE LENGTH DATA PACKET FORMAT.
6	CABLE MODEM TERMINATION SYSTEM DOWNSTREAM RF SIDE INTERFACE (QAM MODULATED).	IP OVER MPEG DATA PACKET FORMAT. CONVERSION FROM IP OVER ATM INCOMING INTO THE CABLE ROUTER IS PERFORMED AUTOMATICALLY BY THE DEVICE.
7	RF FREQUENCY COMBINER (54-750MHz) OVER AN ELECTRICAL LINK.	
8	RF FREQUENCY SPLITTER (5-42MHz) OVER AN ELECTRICAL LINK.	
9	AM-MODULATED OVER OPTICAL FIBER (OPTICAL LINK).	ELECTRICAL TO OPTICAL AND OPTICAL TO ELECTRICAL CONVERSION AT THE HUB IS PERFORMED BY THE TRANSMITTER AND RECEIVER RESPECTIVELY.
10	DIGITAL SET-TOP UNIT INTERFACE OVER THE COAXIAL CABLE FROM THE NODE 107.	OPTICAL TO ELECTRICAL CONVERSION IS PERFORMED AT THE NODE 107.

FIG. 9

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 98/20705

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N5/00 H04N7/173

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 97 13368 A (BRIEN SEAN ANDREW O ;MILNES KENNETH ALAN (US); SCHEIN STEVEN MICHA) 10 April 1997 see page 4, line 1 - page 4, line 16 see page 23, line 16 - page 25, line 14 see page 32, line 37 - page 33, line 20 see figures 8,9,13A-C see figures 14A-E,15A-C	1,4,5,7, 8,10,11, 14-16,19
Y	US 5 638 112 A (BESTLER CAITLIN B ET AL) 10 June 1997 see column 1, line 1 - column 1, line 42	1,4,5,7, 8,10,11, 14-16,19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 January 1999	18/01/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hampson, F

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INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 98/20705

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 33434 A (EARTH WEB INC ;HIDARY JACK D (US); ACTV INC (US); SPIVACK NOVA T () 12 September 1997 see abstract see page 6, line 17 - page 6, line 21 see page 9, line 5 - page 11, line 2 see page 17, line 5 - page 18, line 19 see figure 1	1-19
A	KUWABARA T ET AL: "Satellite multimedia information distribution systems and applications" 19TH ANNUAL PACIFIC TELECOMMUNICATIONS CONFERENCE. PTC '97; PROCEEDINGS OF 19TH PACIFIC TELECOMMUNICATIONS CONFERENCE (PTC'97), HONOLULU, HI, USA, 19-22 JAN. 1997, pages 180-188, XP002089390 ISBN 1-880672-10-3, 1997, Honolulu, HI, USA, Paific Telecommun. Council, USA see page 180, right-hand column, line 14 - page 188, left-hand column, last line; figures 1,3	1-19
P,X	WO 98 00975 A (THOMSON CONSUMER ELECTRONICS ;SUN MICROSYSTEMS INC (US)) 8 January 1998 see abstract see page 2, line 20 - page 3, line 5 see page 4, line 32 - page 6, line 4 see page 6, line 29 - page 8, line 9 see figures 1,3	1,7,9,19
P,A	EP 0 838 929 A (NEXTLEVEL SYSTEMS INC) 29 April 1998 see abstract see column 6, line 21 - column 8, line 3 see figures 3,4	1-19

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte onal Application No
PCT/US 98/20705

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		EP 0880856 A	02-12-1998
		JP 10512420 T	24-11-1998
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		US 5774664 A	30-06-1998
		AU 2070597 A	22-09-1997
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		NO 974955 A	29-04-1998